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WARD CREEK STEELHEAD CREEL SURVEY, KETCHIKAN, ALASKA, OCTOBER 1988 - MAY 1989[1]

By

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ABSTRACT

Based on a direct expansion completed-trip creel survey conducted from 10 October 1988 through 21 May 1989, it was estimated that anglers expended 4,778 angler-hours fishing for steelhead *Oncorhynchus mykiss* on the Ward Creek system. The 95 percent confidence intervals for this estimate were from 3,441 to 6,115 angler-hours. Biweekly estimates of effort ranged from 0 to 1,826 steelhead hours. The estimate for the number of steelhead caught and kept was 384, with 95 percent confidence intervals from 134 to 634, while the estimated number of steelhead caught and released was 293, with 95 percent confidence intervals from 95 to 491. Biweekly estimates of catch ranged from 0 to 153 steelhead kept. Twenty percent of the steelhead caught and kept were hatchery fish.

KEY WORDS: Southeast Alaska, Ketchikan, steelhead, *Oncorhynchus mykiss*, creel census, angler interviews, estimated effort, estimated harvest, hatchery contributions.

INTRODUCTION

Ward Creek drains into Ward Cove and the Tongass Narrows approximately 6.4 km (4 miles) north of Ketchikan, Alaska. Access by anadromous species is limited to the lower reaches of the watershed (Figure 1) by a dam at Connell Lake. The Alaska Department of Fish and Game (ADF&G), Division of Sport Fish, in cooperation with the Division of Fisheries Rehabilitation, Enhancement and Development (FRED), has enhanced the Ward Creek steelhead *Oncorhynchus mykiss* run for the past seven years with hatchery smolts reared either at the Deer Mountain or Klawock Lake hatcheries. Actual plants of steelhead smolts have ranged from 1,200 to 40,000 smolts on an annual basis.

The perceived results of the yearly plants, based on voluntary information provided by local anglers, have varied with levels of enhancement and the intensity of the sport fishery in Ward Creek. During recent years, annual plants in this system have averaged approximately 30,000 steelhead and have produced an increasing number of adult returns to this system. Angler interest in this stream has increased ten fold over past years, and because of easy access via the Ketchikan road system, fishing pressure and harvest have also increased. The combination of the Department's enhancement work and increased angler pressure encouraged the Division of Sport Fish to undertake a creel survey program to estimate angler effort, harvest, and hatchery contribution to the sport fishery.

The first creel survey program ran from 29 February through 19 June 1988, and anglers expended an estimated 3,638 angler-hours (SE = 630) of effort to catch and keep an estimated 359 steelhead (SE = 83). A total of 971 steelhead (SE = 549) were also estimated to have been caught and released. The ratio of non-adipose-clipped steelhead to adipose-clipped steelhead indicated that nine percent of the steelhead that were caught and kept were of hatchery origin (Hubartt 1989). Because of the low percentage of hatchery steelhead that were indicated in the fishery, the creel survey program was continued for one more season, and was extended to cover more of the fall period.

Ward Creek was open to sport fishing throughout 1988 and 1989. Bag, possession, and size limits for trout in combination were five fish per day and 10 fish in possession, but only one fish daily and two fish in possession over 16 inches. The bag limit for steelhead was two fish over 16 inches if at least one of these fish had a clipped adipose fin, as evidenced by a healed scar. A new regulation that became effective in mid-April 1989 designated the area from the Ward Creek bridge to the Connell Lake dam as a single hook area.

The specific objectives of the project were to:

1. Estimate the recreational fishing effort, the number of steelhead caught and kept, the number of steelhead caught and released, and the catch per unit of effort (CPUE) of hatchery-reared and wild steelhead in the Ward Creek fishery from 10 October 1988 to 21 May 1989.

2. Estimate the length frequency distribution and the age composition of the steelhead caught in Ward Creek from 10 October 1988 to 21 May 1989.

METHODS

Data Collection

An on-site direct expansion completed-trip creel survey, based on a stratified random design, was used to estimate effort, catch, and harvest parameters of the Ward Creek steelhead fishery. For the on-site survey, individual anglers were intercepted at discrete access locations during a specified period of time. Counts of fish harvested by all anglers interviewed during the specified time period were expanded upwards for the periods of time for which no samples were taken. Similarly, effort in angler-hours as measured from the same interviews was expanded to obtain the effort estimate.

In the Ward Creek area, there are several access locations to the steelhead fishery. The stream was stratified into three areas related to the major access locations (Figure 1). The three strata were:

1. Area 1 - from the intertidal area at Ward Cove upstream to the canyon area at the outlet of Ward Lake.

2. Area 2 - from the canyon area upstream to first falls above the swinging bridge site.

3. Area 3 - from the first falls above the swinging bridge site upstream to the dam at Connell Lake.

Biweekly strata were established during the period from 10 October 1988 through 21 May 1989. Within each biweekly strata days were further divided into two substrata, weekdays and weekends; all legal holidays were included within the weekend stratum. Angler day lengths and mid-day times were calculated by using civil twilight times; day lengths ranged from 10 to 18.5 hours. In addition, each day was subdivided into early day (before the calculated mid-day time) and late day (after mid-day) substrata, and each substratum was divided into two sample periods of equal length. The early day/late day substrata was dropped during the period from 6 November 1988 through 14 January 1989 because of the reduced number of daylight hours. Finally, each identified area listed above was sampled randomly.

Samples were allocated between weekday and weekend-holiday strata according to the following scheme:

1. Within any week (i.e., Monday-Sunday), all weekend-holidays were selected for sampling.

2. Then two contiguous weekdays were randomly selected without replacement for "non-sampling" (in order to assure 2 days off for staff).

3. For each sampled day, either an early or a late time-of-day substratum was selected. During each selected time-of-day substratum, both of the 2 possible sampling periods were selected. From 6 November 1988 through 15 January 1989, 2 sampling periods of equal length were selected from the entire daylight time available.

4. Finally, one of the three possible areas was selected at random.

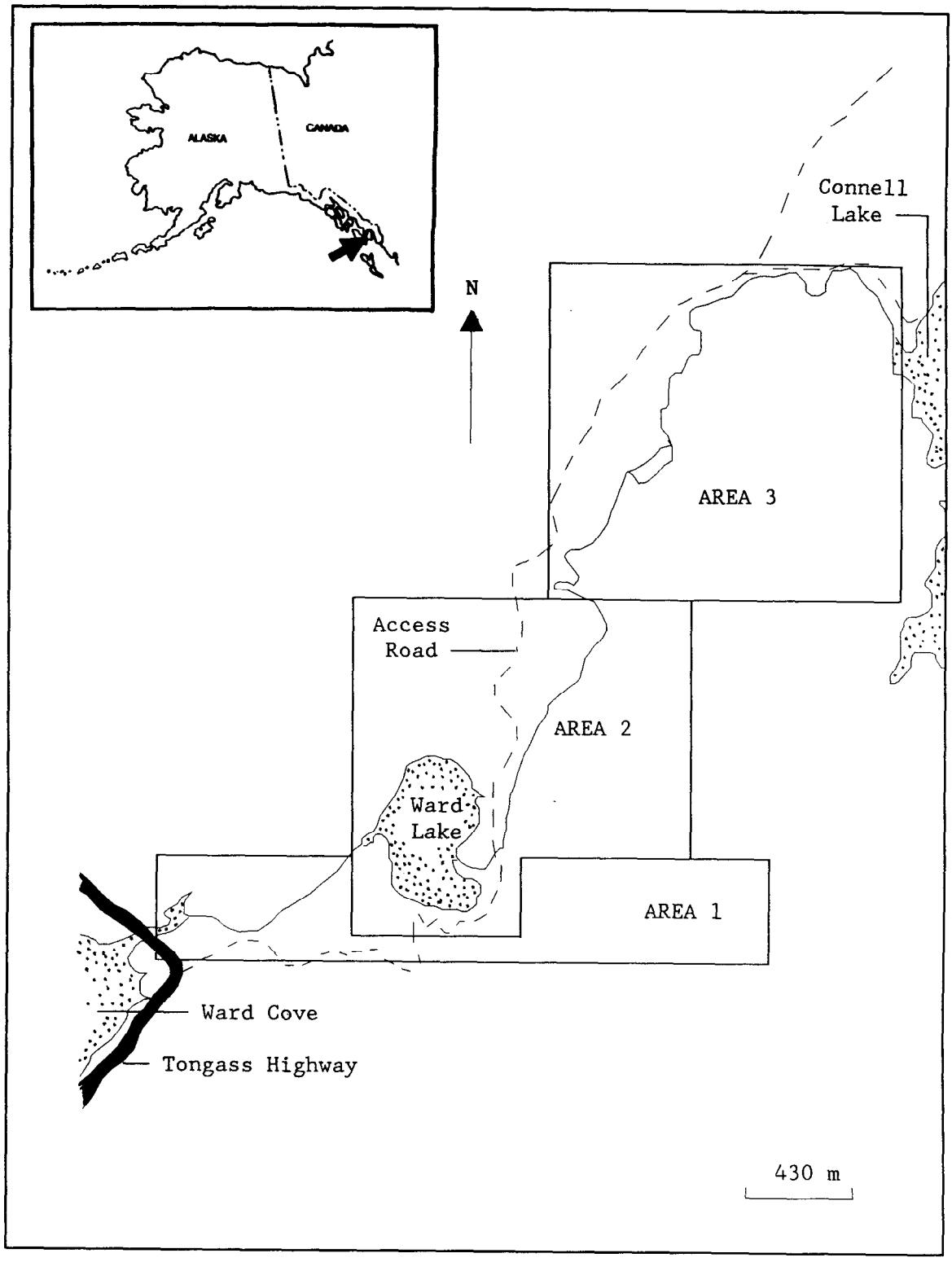


Figure 1. Creel census sampling areas on Ward Creek, 1988-89.

Additionally, logistical constraints (i.e., the time required to travel from one area to another) played an important part in the sample allocation process. In particular, a half-hour break was scheduled between the two sample periods within each day to allow for travel time between sites. The total number of hours sampled each day was limited to six hours to accomodate the time spent traveling to and from Ward Creek, and to permit a small amount of office time.

Creel survey interviews were conducted by a technician who was stationed at a pre-assigned access location. During the assigned sampling period, anglers were interviewed as they completed their fishing activities. All interviewed anglers were questioned to determine how long they had been fishing and how many fish by species they had caught and kept, and caught and released. Anglers were also asked whether they were Alaskan residents, the number of days fished, and the type of gear used. Because it was not always possible to interview all completed trip anglers, both the number of interviewed anglers and the total number of completed trip anglers were recorded.

In addition to interviewing individual anglers, the technician also sampled catches as time allowed. Scales from steelhead were taken from the left side of the fish two rows above the lateral line and on the diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin. If scales in this area were damaged, the same area on the right side of the fish was sampled. A total of ten scales were taken from each fish and were mounted on gum cards. Lengths (mid-eye to fork of tail) were recorded to the nearest millimeter and weights were recorded to the nearest gram.

For the purposes of this study, any steelhead with a missing adipose fin was presumed to be of hatchery origin. When encountered in the sport harvest, the heads of these steelhead were retained. A cinch strap with a unique number was inserted through the jaw of each fish. Heads and relevant recovery information were forwarded to the ADF&G Tag Lab for coded wire tag (CWT) removal and decoding. Heads were classified as random (randomly sampled during scheduled creel surveys) or select (turned in voluntarily).

Steelhead scales were pressed onto acetates and ages were determined by viewing the acetates with a microfiche reader. Aging of scales was conducted using methods described by Narver and Withler (1977); repeat spawners are reported with an "S" after the ocean age to denote a successful spawning run and survival. Therefore, a steelhead with an age of 3.2S1 is six years old: three years were spent in freshwater before smolt emigration; two years (winters) were then spent in saltwater, after which it returned to freshwater and spawned ("S"). This steelhead survived another year in saltwater (1) and had returned to freshwater on its second spawning run. Initial spawning steelhead are those fish without an "S" in their total age designation.

Data Analysis

The following equations were used to estimate effort and harvest for this creel survey. These equations are valid when all completed trip anglers leaving the fishery are interviewed, as well as when some anglers are missed, but all completed trip anglers in the area and time stratum being sampled are counted.

The first step involves the estimation of angler effort:

$\hat{E}_h$ = $R_h \frac{\bar{e}_h}{\bar{r}_h}$ (1)

h = subscript denoting stratum (as defined by the combination of seasonal period, access location type, type of fishing day [i.e., weekday or weekend holiday], and time-of-day [i.e., early versus late day]);

R_h = total number of hours (available for fishing) in the hth stratum;

$\bar{e}_h$ = mean effort over all samples within the hth stratum;

= $\frac{\sum_{i=1}^{n_h} \hat{e}_{hi}}{n_h}$ (2)

i = subscript denoting an individual sample within the hth stratum;

n_h = number of samples collected within the hth stratum;

$\hat{e}_{hi}$ = estimated effort for the ith sample within the hth stratum;

= $o_i \bar{e}_{hi}$ (3)

o_i = number of anglers counted in the ith sample within the hth stratum (including interviewed anglers and "missed" anglers);

= $o_i + p_i$ (4)

o_i = number of anglers interviewed during the ith sample;

p_i = number of anglers not interviewed (i.e., "missed") during the ith sample;

$\bar{e}_{hi}$ = $\frac{\sum_{j=1}^{o_i} e_{hij}}{o_i}$ (5)

j = subscript denoting the angler interviewed during the ith sample within the hth stratum;

e_{hij} = effort (in angler-hours) of the jth angler interviewed in the ith sample in the hth stratum;

r_{hi} = hours sampled during the ith sample in the hth stratum;

$\hat{V}_h(\hat{E}_h)$ = the variance estimate for the estimate of E_h, obtained by the standard formula for the estimation of the variance of a product of a constant and a variance (Lehmann 1975);

$$= R_h^2 \hat{V}\left[\frac{\bar{e}_h}{\bar{r}_h}\right] \quad (6)$$

$\hat{V}\left[\frac{\bar{e}_h}{\bar{r}_h}\right]$ = the variance estimate for the ratio of the mean effort expended by anglers in all samples and the mean hours sampled within the hth stratum, which is estimated approximately by the standard formula for the variance of the ratio of random variables (Cochran 1977, section 6.3);

$$\approx \left[\frac{\bar{e}_h}{\bar{r}_h}\right]^2\left\{\left[\frac{s_e^2}{\bar{e}_h^2}\right] + \left[\frac{s_r^2}{\bar{r}_h^2}\right] - \left[\frac{2\mathrm{cov}(e,r)}{\bar{e}_h\bar{r}_h}\right]\right\} \quad (7)$$

$\bar{r}_h$ = mean number of hours sampled over all samples within the hth stratum;

$$= \frac{\sum_{i=1}^{n_h} r_{hi}}{n_h} \quad (8)$$

s_e^2 = variance estimate associated with estimating the effort component of the effort rate;

$$= \left[\frac{R_h - r_h}{R_h}\right]\left[\frac{s_{B_e}^2}{n_h}\right] + \left[\frac{O_h - o_h}{R_h O_h}\right]\left[\frac{s_{W_e}^2}{o_h}\right] \quad (9)$$

$s_{B_e}^2$ = the between sample variance for effort;

$$= \frac{\sum_{i=1}^{n_h} (\bar{e}_{hi} - \bar{e}_h)^2}{n_h - 1} \quad (10)$$

$$O_h = \sum_{i=1}^{n_h} O_i \quad (11)$$

$$o_h = \sum_{i=1}^{n_h} o_i \quad (12)$$

$s_{W_e}^2$ = the within sample (between angler) variance for effort;

$$= \left[\frac{O_i^2}{o_i}\right]\left[\frac{\sum_{j=1}^{o_i} (e_{hij} - \bar{e}_{hi})^2}{(o_i - 1)}\right] \quad (13)$$

s_r^2 = variance estimate associated with estimating the hours sampled component of the effort rate;

$$= \left[\frac{(R_h - r_h)}{R_h n_h}\right]\left[\frac{\sum_{i=1}^{n_h} (r_{hi} - \bar{r}_h)^2}{(n_h - 1)}\right] \quad (14)$$

$\text{cov}(e,r)$ = estimate of the the covariance between the effort and hours sampled components of the effort rate estimate;

$$= \left[\frac{(R_h - r_h)}{R_h n_h}\right]\left[\frac{\sum_{i-1}^{n_h}(\hat{e}_{hi}-\bar{e}_h)(r_{hi}-\bar{r}_h)}{n_h-1}\right] \quad (15)$$

The final step in estimating the effort for the entire season involved combining the stratum estimates;

$\hat{E}$ = overall estimated effort;

$$= \sum_{h=1}^{q} E_h \quad (16)$$

q = number of strata;

$\hat{V}(\hat{E})$ = estimated variance of E, assuming independence of the stratum estimates;

$$= \sum_{h=1}^{q} \hat{V}_h(\hat{E}_h) \quad (17)$$

Approximate 95% confidence interval (CI)limits were obtained for angler effort, catch, and harvest estimates as follows, by assuming normality (Cochran 1977):

95% CI = $\hat{Y} \pm 1.96(\hat{V}[\hat{Y}])^{0.5}$ (18)

$\hat{Y}$ = estimate of the total parameter of interest (e.g., E, C, or H for effort, catch, or harvest), note that individual stratum estimates (as obtained by equations noted above) can be used or totals across strata; and

$\hat{V}[\hat{Y}]$ = estimate of the variance of the total parameter of interest (as obtained by equations noted above).

Harvest was estimated similarly by substituting the corresponding catch statistics in place of the effort statistics into equations 1-18, above.

Note, that the approach as presented above, for variance estimation, is valid for a simple stratified random sampling design with only one stage of sample selection. Our use of this approach was not entirely correct, in that selection of the time to sample (within a unique combination of strata definitions) was not a simple random process; and the location to sample within area strata represented a second stage of sampling. Due to the complexities of the sample allocation process and due to the limitations of sampling density, we were not able to estimate the variance for the second stage (i.e., by using squared differences between sample means and means by location [and/or sample period]).

The use of this approach introduces some unknown level of bias into our variance estimates. We assume that this bias is negative, because there are components of variance which we do not estimate. Accordingly, the reported levels of variance are minimal estimates.

The assumptions necessary for our effort, catch, and harvest estimates to be unbiased include the following:

1. anglers accurately report their hours of fishing effort and the number by species (and class, e.g. adipose-clipped or not) of fish caught and kept and of fish caught and released;

2. no significant fishing effort occurred between 2200 hours and 0600 hours;

3. all anglers participating in the fishery leave the fishery through one of the surveyed areas;

4. all anglers who are not interviewed are counted, and all anglers who are interviewed are completed-trip anglers; and

5. harvest, catch, and effort by individual anglers are normally distributed random variables; this assumption is necessary for the 95% confidence intervals to be unbiased.

The first assumption is the most troublesome of the five assumptions because there is no way to guarentee that every angler will accurately report their effort and harvest. In many cases the creel technicians may actually observe how many hours the angler fished, and how many fish were kept, but rarely do they observe anglers releasing fish. So, although observation supports the first assumption regarding to effort and the number of fish caught and kept, we cannot be confident that the reports of the number of fish caught and released are as accurate. Even if all anglers accurately reported the number of released fish, we have no way of knowing how many of these fish had been caught repeatedly. To the best of our knowledge assumptions two, three, and four were true. Although we use assumption five to calculate the estimates of harvest, catch, and effort, these variables do not usually fit a normal distribution exactly. In general we expect actual variances to be greater than calculated variances, although we do not feel that the difference is large.

The contribution of hatchery steelhead trout to the Ward Creek sport fishery was estimated from the ratio of the estimate for the number of adipose-clipped steelhead kept to the estimate for all steelhead kept. The use of the ratio of the two estimates should be valid, since 100% of the hatchery steelhead released in the system and returning during the sampling period were adipose-clipped.

Mean length and mean weight of steelhead with the associated standard errors were estimated using standard statistical procedures (Sokal and Rohlf 1981, Boxes 4.2 and 7.1, pages 56 and 139). Standard errors for the proportion of steelhead within each age class were calculated using the following formula from Cochran 1977:

$$SE(\hat{p}_c) = \frac{(\hat{p}_c)(1-\hat{p}_c)}{n-1} \qquad (19)$$

where:

$\hat{p}_c$ = estimated proportion in age class "c", which is equal to the number of fish in age class "c" divided by the number of fish aged (sample size = n)

n = the number of fish aged

Harvests of kept and released fish that were adipose-clipped, non-clipped, or of unknown clip status were estimated for each of the following species: steelhead and rainbow trout *Oncorhynchus mykiss*, cutthroat trout *O. clarki*, Dolly Varden *Salvilinus malma*, and coho salmon *O. kisutch*.

RESULTS

Estimates of Effort and Catch

During the period from 10 October 1988 to 21 May 1989, the total estimated effort was 4,848 angler-hours (95% CI from 3,536 to 6,220). Over 98 percent of this effort (4,778 angler-hours) was directed toward steelhead, and less than 2 percent (70 angler-hours) was directed toward other species of trout, salmon or char. Table 1 presents the estimated effort for steelhead and for other species by biweekly period and illustrates that most of the effort occurred during the last two biweekly periods sampled (i.e. 24 April - 21 May).

An estimated 384 steelhead (95% CI limits of 134 to 634) were caught and kept during the period from 10 October 1988 to 21 May 1989 (Table 2), and 293 (95% CI of 95 to 491) were caught and released. A majority of both wild (92%) and hatchery (57%) steelhead harvested were caught during the 24 April to 21 May 1989 period (Table 3). Similarly, 94% of the wild and 71% of the hatchery steelhead that were caught and released were caught by anglers fishing during this period. Almost 20 percent (76 of 384) of the estimated number of steelhead caught and kept were hatchery (adipose-clipped) fish.

Sampling periods and strata are presented in Appendix A, along with the numbers of anglers counted and interviewed during each sampling period.

Eighty-seven percent of the completed trip anglers interviewed were Alaska residents, and 13% were non-resident. During the creel survey interviews, anglers were also asked if they used spinners, flies, bait (salmon eggs), or other artificial lures. Responses to this question indicated that 15% used spinners, 34% used flies, 44% used bait, and 7% used artificial lures other than spinners or flies.

Age-Weight-Length (AWL)

A total of 32 steelhead were examined during the creel survey period. Six of these fish were coded-wire-tagged fish of hatchery origin, and the remaining 26 were wild. Ten of the fish examined were males, 15 were females, and the sex of seven fish was not determined. Lengths ranged from 600 mm (24 in.) to 890 mm (35 in.) and the mean length was 687 mm (27 in.) with a standard error (SE) of 12mm (0.5 in.) (Figure 2). Weights ranged from 2.3 kg (5 lbs.) to 6.4 kg (14 lbs.) and averaged 4.0 kg (8.7 lbs) with a SE of 0.2 kg (0.3 lbs.). Ages ranged from 2.3 to 4.3 years. Table 4 displays the number of steelhead trout in each age category, and indicates that nine of these fish (all wild) were repeat spawners. The freshwater age of all the hatchery fish, and four of the wild fish could not be determined because of scale regeneration.

Table 1. Estimated steelhead effort (angler-hours) in Ward Creek by biweekly period, 1988-89.

Date	Biweekly Period	Steelhead Effort Hours	SE	Other Effort[a] Hours	SE
10 Oct - 23 Oct 88	21	85	41	0	
24 Oct - 06 Nov 88	22	121	81	0	
07 Nov - 20 Nov 88	23	80	61	0	
21 Nov - 04 Dec 88	24	66	31	0	
05 Dec - 18 Dec 88	25	91	51	0	
19 Dec - 01 Jan 89	26	9	8	0	
02 Jan - 15 Jan 89	1	16	15	0	
16 Jan - 29 Jan 89	2	103	53	13	13
30 Jan - 12 Feb 89	3	0		0	
13 Feb - 26 Feb 89	4	70	48	0	
27 Feb - 12 Mar 89	5	7	6	0	
13 Mar - 26 Mar 89	6	141	60	4	4
27 Mar - 09 Apr 89	7	621	236	0	
10 Apr - 23 Apr 89	8	409	179	10	9
24 Apr - 07 May 89	9	1,825	465	11	11
08 May - 21 May 89	10	1,134	372	32	22
Total		4,778	682	70	29

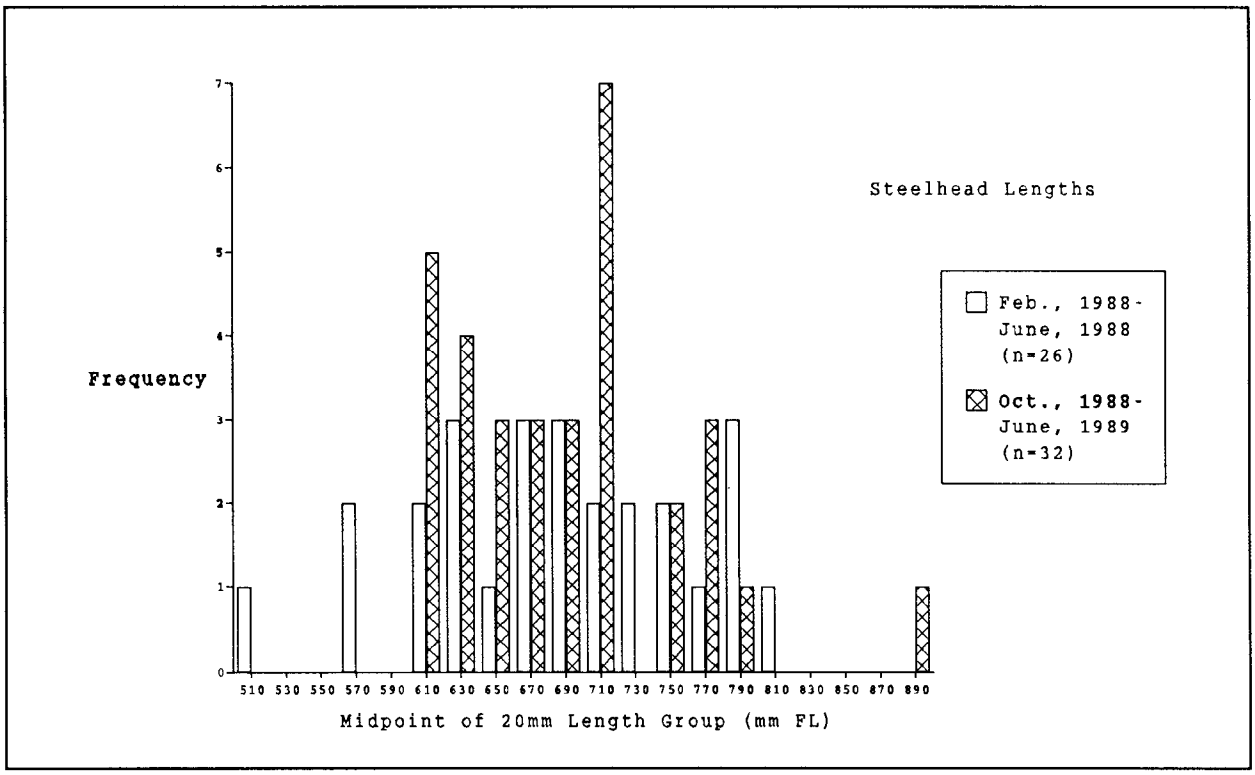
[a] includes hours fished for salmon and other species of trout.

Table 2. Estimated angler effort and catches for Ward Creek, 10 October 1988 through 21 May 1989.

		ESTIMATE	SE
ANGLER-HOURS	Steelhead	4,778	682
	Salmon	11	11
	Other-target	59	27
	Total	4,848	685
STEELHEAD KEPT	Non-clipped	308	97
	Adipose-clipped	76	39
	Unknown clip status	0	0
	All	384	128
STEELHEAD RELEASED	Non-clipped	262	95
	Adipose-clipped	31	20
	Unknown clip status	0	0
	All	293	101
RAINBOW TROUT	Kept	23	17
	Released	25	24
CUTTHROAT TROUT	Kept	9	9
	Released	19	14
DOLLY VARDEN	Kept	103	54
	Released	120	66
COHO SALMON KEPT	All	0	0
COHO SALMON RELEASED	Non-clipped	46	36
	Adipose-clipped	0	0
	All	46	36

Table 3. Estimated steelhead catch (kept and released) in Ward Creek by biweekly period, 1988-89.

Date	Biweekly Period	Wild Steelhead Kept N	Wild Steelhead Kept SE	Wild Steelhead Released N	Wild Steelhead Released SE	Hatchery (CWT) Steelhead Kept N	Hatchery (CWT) Steelhead Kept SE	Hatchery (CWT) Steelhead Released N	Hatchery (CWT) Steelhead Released SE
10 Oct - 23 Oct 88	21	0		0		0		0	
24 Oct - 06 Nov 88	22	0		0		0		0	
07 Nov - 20 Nov 88	23	0		0		6	6	0	
21 Nov - 04 Dec 88	24	7	7	15	9	19	10	0	
05 Dec - 18 Dec 88	25	4	4	0		0		9	7
19 Dec - 01 Jan 89	26	0		0		0		0	
02 Jan - 15 Jan 89	1	0		0		0		0	
16 Jan - 29 Jan 89	2	0		0		0		0	
30 Jan - 12 Feb 89	3	0		0		0		0	
13 Feb - 26 Feb 89	4	0		0		0		0	
27 Feb - 12 Mar 89	5	0		0		0		0	
13 Mar - 26 Mar 89	6	0		0		0		0	
27 Mar - 09 Apr 89	7	0		0		0		0	
10 Apr - 23 Apr 89	8	13	13	0		8	8	0	
24 Apr - 07 May 89	9	129	44	166	82	7	7	22	19
08 May - 21 May 89	10	155	87	81	49	36	35	0	
Total		308	97	262	95	76	39	31	20



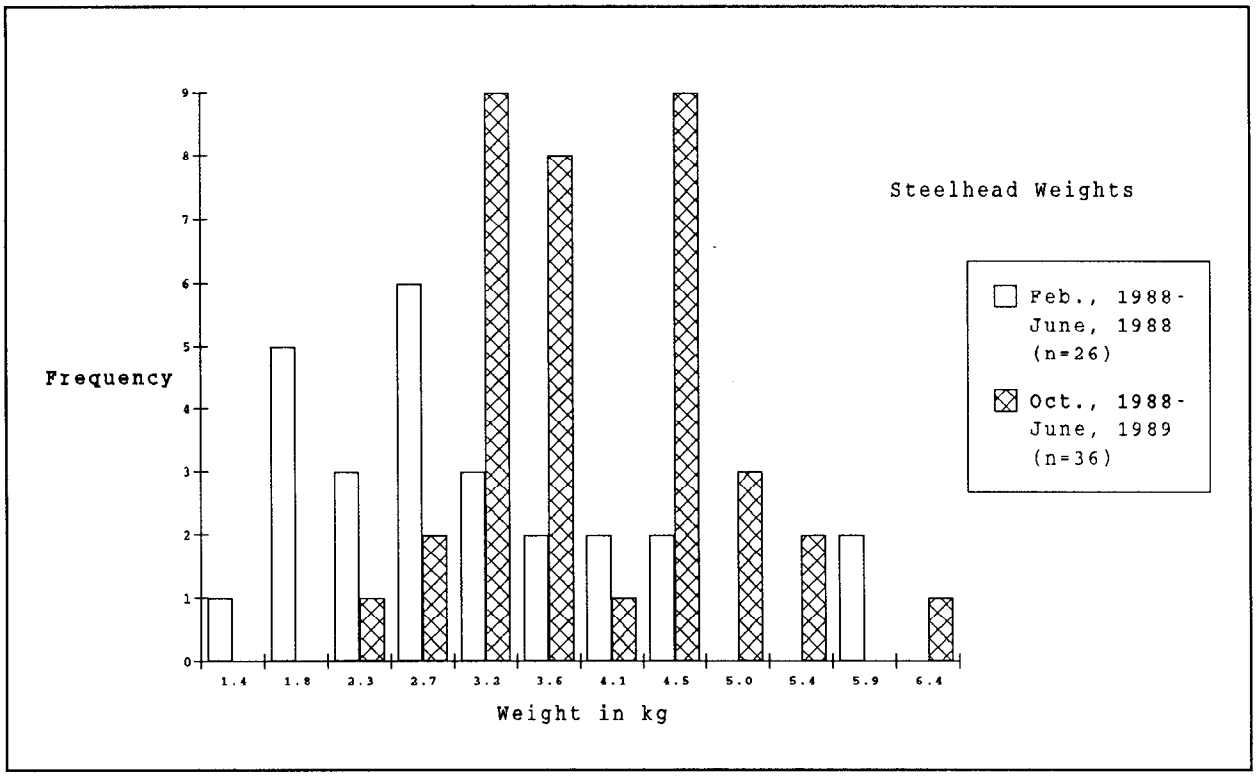


Figure 2. Length and weight frequency distributions from steelhead trout collected at Ward Creek from February 1988 to June 1988 (Hubartt 1989) and from October 1988 to June 1989.

Table 4. Age distribution of steelhead collected from Ward Creek, 1988-89.

Age Class[a]	Number of Steelhead	Proportion of Total	SE
R.2[b]	1	0.031	0.0001
R.2S1	1	0.031	0.0001
R.3	2	0.063	0.0019
H.3[c]	6	0.188	0.0049
2.2S1	1	0.031	0.0001
2.2S1S1	1	0.031	0.0001
2.3	3	0.094	0.0027
3.2	6	0.188	0.0049
3.2S1	4	0.125	0.0035
3.2S1S1	1	0.031	0.0001
3.3	4	0.125	0.0035
4.2S1	1	0.031	0.0001
4.3	1	0.031	0.0001
TOTAL	32	1.000	

[a] Aging of scales was conducted using methods described by Narver and Withler (1977)

[b] R indicates scale regeneration which prevented accurate determination of the freshwater age.

[c] H indicates hatchery (CWT) fish. Scale regeneration prevented accurate determination of the freshwater age in all of these fish.

DISCUSSION

The Ward Creek steelhead fishery provides recreational fishing primarily for local anglers during late winter and early spring. Information from the statewide harvest survey (Mills 1983, 1984, 1985, 1986, 1987, and 1988) indicates that the estimated harvest of steelhead trout from 1982 through 1987 has varied from 94 to 547 fish, and has averaged 296 fish. Last season's (29 February through 19 June 1988) estimated harvest of 359 steelhead (Hubartt 1989), and this season's (10 October 1988 through 21 May 1989) estimated harvest of 384 steelhead do not seem to indicate any major changes in the overall number of the steelhead harvested in the Ward Creek system (Figure 3). The estimated number of steelhead released was 293. This estimate is less than one-third of the estimated number of steelhead trout released during the previous creel survey period.

Efforts directed toward enhancing the steelhead run by stocking smolts from the Klawock hatchery on Prince of Wales Island (30,000 in 1984, 28,553 in 1985, 28,687 in 1986, and 20,000 in 1987) have apparently not been very successful, as indicated by the low number of adipose-clipped steelhead trout estimated to have been harvested last season (32 clipped fish in a total harvest of 359) and this season (76 clipped fish in a total harvest of 384).

ACKNOWLEDGEMENTS

I would like to express my thanks to Evon Zerbetz and Kathleen Wendt for conducting the angler interviews, recording the distribution of fishing effort and spawning steelhead, and for producing hand-drawn maps of the Ward Creek system. I would like to thank Jerrold Koerner for aging the steelhead scales that were collected. I would also like to thank Allen Bingham who provided biometric support in the form of methods, equations, and computer programs for estimating harvest and effort.

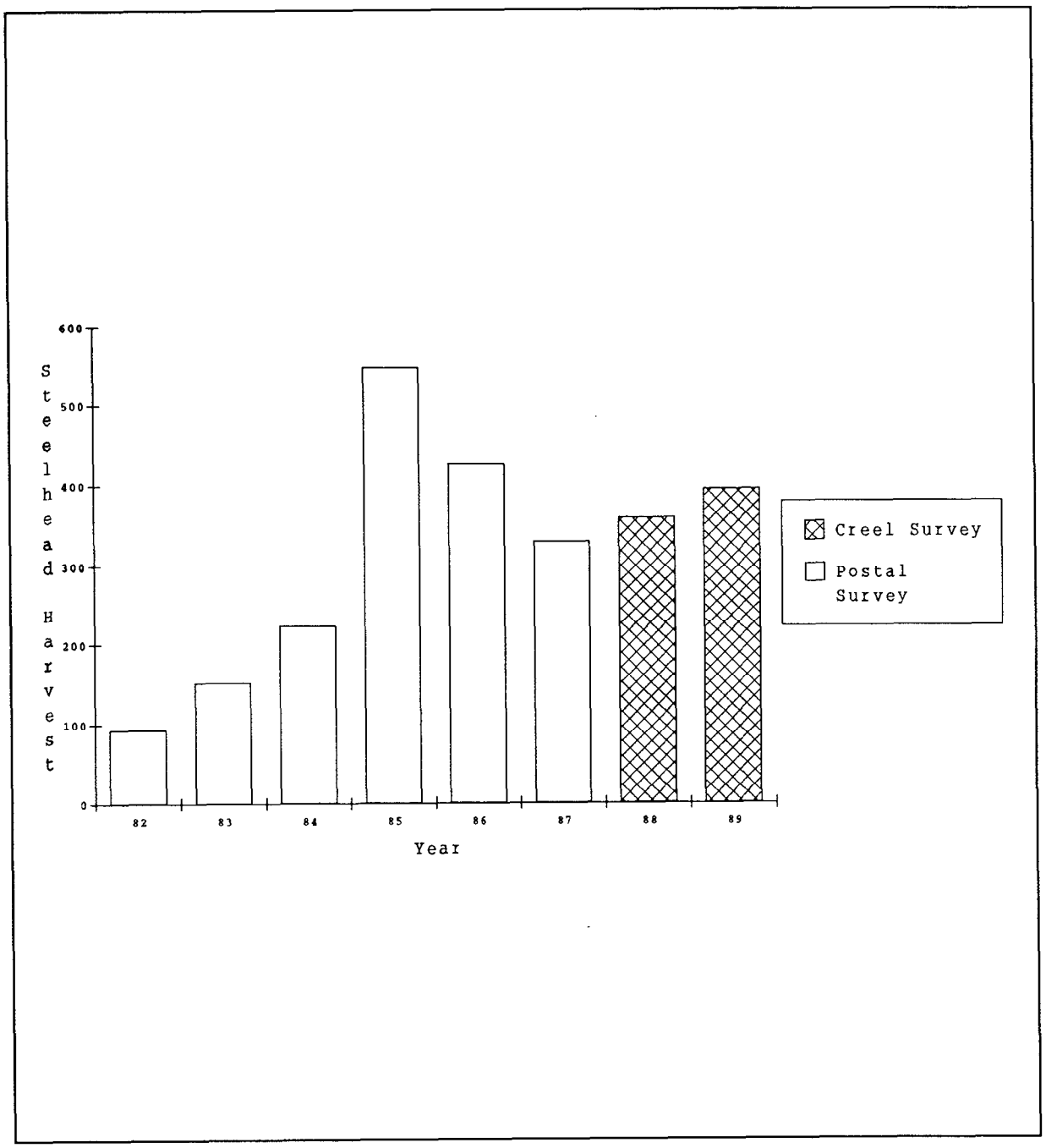


Figure 3. Estimated harvest of steelhead in Ward Creek, 1982–89 (postal survey data from Mills 1983, 1984, 1985, 1986, 1987, and 1988; and creel survey data from Hubartt 1989).

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APPENDIX A

Appendix A1. Sampling periods and strata, Ward Creek, 1988–89.

Biweekly Period	Date of Sample	A[a]	B[b]	Start[c]	End[d]	C[e]	Samptime[f]	Count[g]	Interv[h]
10OCT88 – 23OCT88	10OCT88	1	2	12:55	15:32	3	2.617	0	0
10OCT88 – 23OCT88	10OCT88	1	2	15:52	18:30	2	2.633	3	3
10OCT88 – 23OCT88	11OCT88	1	1	7:00	9:37	2	2.617	0	0
10OCT88 – 23OCT88	11OCT88	1	1	10:07	12:45	2	2.633	1	1
10OCT88 – 23OCT88	14OCT88	1	2	12:50	15:27	2	2.617	0	0
10OCT88 – 23OCT88	14OCT88	1	2	15:52	18:30	3	2.633	0	0
10OCT88 – 23OCT88	15OCT88	2	2	12:45	15:22	2	2.617	0	0
10OCT88 – 23OCT88	15OCT88	2	2	15:52	18:30	3	2.633	0	0
10OCT88 – 23OCT88	16OCT88	2	1	7:15	9:45	3	2.500	0	0
10OCT88 – 23OCT88	16OCT88	2	1	10:15	12:45	3	2.500	0	0
10OCT88 – 23OCT88	17OCT88	1	1	7:00	9:30	2	2.500	0	0
10OCT88 – 23OCT88	17OCT88	1	1	10:00	12:30	2	2.500	1	1
10OCT88 – 23OCT88	18OCT88	1	2	12:30	15:00	3	2.500	0	0
10OCT88 – 23OCT88	18OCT88	1	2	15:30	18:00	3	2.500	0	0
10OCT88 – 23OCT88	19OCT88	1	2	12:30	15:00	3	2.500	0	0
10OCT88 – 23OCT88	19OCT88	1	2	15:30	18:00	3	2.500	0	0
10OCT88 – 23OCT88	22OCT88	2	2	12:30	15:00	3	2.500	0	0
10OCT88 – 23OCT88	22OCT88	2	2	15:30	18:00	3	2.500	0	0
10OCT88 – 23OCT88	23OCT88	2	1	7:00	9:30	3	2.500	0	0
10OCT88 – 23OCT88	23OCT88	2	1	10:00	12:30	2	2.500	1	1
24OCT88 – 06NOV88	24OCT88	1	2	12:30	14:52	2	2.367	2	2
24OCT88 – 06NOV88	24OCT88	1	2	15:22	17:45	2	2.383	1	1
24OCT88 – 06NOV88	27OCT88	1	1	7:15	9:37	3	2.367	0	0
24OCT88 – 06NOV88	27OCT88	1	1	10:07	12:30	3	2.383	0	0
24OCT88 – 06NOV88	28OCT88	1	2	12:30	14:52	3	2.367	0	0
24OCT88 – 06NOV88	28OCT88	1	2	15:22	17:45	2	2.383	0	0
24OCT88 – 06NOV88	29OCT88	2	2	12:30	14:32	3	2.033	0	0
24OCT88 – 06NOV88	29OCT88	2	2	15:22	17:45	3	2.383	0	0
24OCT88 – 06NOV88	30OCT88	2	1	6:15	8:37	3	2.367	0	0
24OCT88 – 06NOV88	30OCT88	2	1	9:07	11:30	3	2.383	0	0
24OCT88 – 06NOV88	31OCT88	1	1	6:30	8:45	2	2.250	0	0
24OCT88 – 06NOV88	31OCT88	1	1	9:15	11:30	3	2.250	0	0
24OCT88 – 06NOV88	03NOV88	1	2	11:30	13:45	3	2.250	0	0
24OCT88 – 06NOV88	03NOV88	1	2	14:15	16:30	3	2.250	0	0
24OCT88 – 06NOV88	04NOV88	1	2	11:30	13:45	2	2.250	0	0
24OCT88 – 06NOV88	04NOV88	1	2	14:15	16:30	2	2.250	3	2
24OCT88 – 06NOV88	05NOV88	2	2	11:30	13:45	3	2.250	0	0
24OCT88 – 06NOV88	05NOV88	2	2	14:15	16:30	3	2.250	0	0
24OCT88 – 06NOV88	06NOV88	2	1	6:30	8:45	3	2.250	0	0
24OCT88 – 06NOV88	06NOV88	2	1	9:15	11:30	3	2.250	0	0

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Biweekly Period	Date of Sample	A[a]	B[b]	Start[c]	End[d]	C[e]	Samptime[f]	Count[g]	Interv[h]
07NOV88 - 20NOV88	07NOV88	1	3	7:00	10:00	2	3.000	2	1
07NOV88 - 20NOV88	07NOV88	1	3	10:30	13:30	3	3.000	0	0
07NOV88 - 20NOV88	08NOV88	1	3	7:00	10:00	3	3.000	0	0
07NOV88 - 20NOV88	08NOV88	1	3	10:30	13:30	2	3.000	1	0
07NOV88 - 20NOV88	11NOV88	1	3	8:30	11:30	3	3.000	0	0
07NOV88 - 20NOV88	11NOV88	1	3	12:00	15:00	2	3.000	0	0
07NOV88 - 20NOV88	12NOV88	2	3	10:00	13:00	3	3.000	0	0
07NOV88 - 20NOV88	12NOV88	2	3	13:30	16:30	2	3.000	6	6
07NOV88 - 20NOV88	13NOV88	2	3	7:00	10:00	3	3.000	0	0
07NOV88 - 20NOV88	13NOV88	2	3	10:30	13:30	2	3.000	1	0
07NOV88 - 20NOV88	14NOV88	1	3	9:45	12:45	3	3.000	0	0
07NOV88 - 20NOV88	14NOV88	1	3	13:15	16:15	3	3.000	0	0
07NOV88 - 20NOV88	15NOV88	1	3	9:45	12:45	3	3.000	0	0
07NOV88 - 20NOV88	15NOV88	1	3	13:15	16:15	2	3.000	0	0
07NOV88 - 20NOV88	16NOV88	1	3	9:45	12:45	3	3.000	0	0
07NOV88 - 20NOV88	16NOV88	1	3	13:15	16:15	3	3.000	0	0
07NOV88 - 20NOV88	19NOV88	2	3	6:45	9:45	3	3.000	0	0
07NOV88 - 20NOV88	19NOV88	2	3	10:15	13:15	3	3.000	0	0
07NOV88 - 20NOV88	20NOV88	2	3	9:45	12:45	3	3.000	0	0
07NOV88 - 20NOV88	20NOV88	2	3	13:15	16:15	3	3.000	0	0
21NOV88 - 04DEC88	21NOV88	1	3	8:15	11:15	2	3.000	2	2
21NOV88 - 04DEC88	21NOV88	1	3	11:45	14:45	2	3.000	0	0
21NOV88 - 04DEC88	22NOV88	1	3	8:15	11:15	3	3.000	0	0
21NOV88 - 04DEC88	22NOV88	1	3	11:45	14:45	2	3.000	0	0
21NOV88 - 04DEC88	25NOV88	1	3	8:15	11:15	2	3.000	0	0
21NOV88 - 04DEC88	25NOV88	1	3	11:45	14:45	3	3.000	0	0
21NOV88 - 04DEC88	26NOV88	2	3	7:00	10:00	2	3.000	1	1
21NOV88 - 04DEC88	26NOV88	2	3	10:30	13:30	2	3.000	0	0
21NOV88 - 04DEC88	27NOV88	2	3	7:00	10:00	3	3.000	0	0
21NOV88 - 04DEC88	27NOV88	2	3	10:30	13:30	3	3.000	0	0
21NOV88 - 04DEC88	30NOV88	1	3	9:30	12:30	3	3.000	0	0
21NOV88 - 04DEC88	30NOV88	1	3	13:00	16:00	3	3.000	0	0
21NOV88 - 04DEC88	01DEC88	1	3	8:30	11:30	2	3.000	2	2
21NOV88 - 04DEC88	01DEC88	1	3	12:00	15:00	3	3.000	0	0
21NOV88 - 04DEC88	02DEC88	1	3	7:30	10:30	2	3.000	1	1
21NOV88 - 04DEC88	02DEC88	1	3	11:00	14:00	2	3.000	0	0
21NOV88 - 04DEC88	03DEC88	2	3	7:30	10:30	3	3.000	0	0
21NOV88 - 04DEC88	03DEC88	2	3	11:00	14:00	3	3.000	0	0
21NOV88 - 04DEC88	04DEC88	2	3	9:30	12:30	2	3.000	1	1
21NOV88 - 04DEC88	04DEC88	2	3	13:00	16:00	3	3.000	0	0

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Biweekly Period	Date of Sample	A[a]	B[b]	Start[c]	End[d]	C[e]	Samptime[f]	Count[g]	Interv[h]
05DEC88 - 18DEC88	05DEC88	1	3	9:45	12:45	2	3.000	0	0
05DEC88 - 18DEC88	05DEC88	1	3	13:00	16:00	2	3.000	0	0
05DEC88 - 18DEC88	08DEC88	1	3	7:30	10:30	3	3.000	0	0
05DEC88 - 18DEC88	08DEC88	1	3	11:00	14:00	2	3.000	0	0
05DEC88 - 18DEC88	09DEC88	1	3	9:30	12:30	3	3.000	0	0
05DEC88 - 18DEC88	09DEC88	1	3	13:00	16:00	3	3.000	0	0
05DEC88 - 18DEC88	10DEC88	2	3	7:30	10:30	3	3.000	0	0
05DEC88 - 18DEC88	10DEC88	2	3	11:00	14:00	3	3.000	0	0
05DEC88 - 18DEC88	11DEC88	2	3	8:30	11:30	2	3.000	5	5
05DEC88 - 18DEC88	11DEC88	2	3	12:00	15:00	2	3.000	5	5
05DEC88 - 18DEC88	12DEC88	1	3	9:30	11:30	3	2.000	0	0
05DEC88 - 18DEC88	12DEC88	1	3	13:00	16:00	3	3.000	0	0
05DEC88 - 18DEC88	13DEC88	1	3	8:30	11:30	3	3.000	0	0
05DEC88 - 18DEC88	13DEC88	1	3	12:00	15:00	3	3.000	0	0
05DEC88 - 18DEC88	14DEC88	1	3	9:30	12:30	2	3.000	0	0
05DEC88 - 18DEC88	14DEC88	1	3	13:00	16:00	3	3.000	0	0
05DEC88 - 18DEC88	17DEC88	2	3	8:30	11:30	2	3.000	0	0
05DEC88 - 18DEC88	17DEC88	2	3	12:00	15:00	2	3.000	2	2
05DEC88 - 18DEC88	18DEC88	2	3	7:30	10:30	3	3.000	0	0
05DEC88 - 18DEC88	18DEC88	2	3	11:00	14:00	3	3.000	0	0
19DEC88 - 31DEC88	19DEC88	1	3	8:30	11:30	3	3.000	0	0
19DEC88 - 31DEC88	19DEC88	1	3	12:00	15:00	3	3.000	0	0
19DEC88 - 31DEC88	20DEC88	1	3	7:30	10:30	3	3.000	0	0
19DEC88 - 31DEC88	20DEC88	1	3	11:00	14:00	3	3.000	0	0
19DEC88 - 31DEC88	21DEC88	1	3	7:30	10:30	3	3.000	0	0
19DEC88 - 31DEC88	21DEC88	1	3	11:00	14:00	3	3.000	0	0
19DEC88 - 31DEC88	24DEC88	2	3	7:30	10:30	3	3.000	0	0
19DEC88 - 31DEC88	24DEC88	2	3	11:00	14:00	3	3.000	0	0
19DEC88 - 31DEC88	29DEC88	1	3	7:30	10:30	3	3.000	0	0
19DEC88 - 31DEC88	29DEC88	1	3	11:00	14:00	3	3.000	0	0
19DEC88 - 31DEC88	30DEC88	1	3	9:30	12:30	2	3.000	0	0
19DEC88 - 31DEC88	30DEC88	1	3	13:00	16:00	2	3.000	2	2
19DEC88 - 31DEC88	31DEC88	2	3	8:30	11:30	3	3.000	0	0
19DEC88 - 31DEC88	31DEC88	2	3	12:00	15:00	2	3.000	0	0

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Biweekly Period	Date of Sample	A[a]	B[b]	Start[c]	End[d]	C[e]	Samptime[f]	Count[g]	Interv[h]
01JAN89 - 15JAN89	01JAN89	2	2	12:45	16:00	3	3.250	0	0
01JAN89 - 15JAN89	01JAN89	2	3	9:00	12:15	2	3.250	1	1
01JAN89 - 15JAN89	02JAN89	1	3	7:45	11:00	3	3.250	0	0
01JAN89 - 15JAN89	02JAN89	1	3	11:30	14:45	3	3.250	0	0
01JAN89 - 15JAN89	03JAN89	1	3	7:45	11:00	3	3.250	0	0
01JAN89 - 15JAN89	03JAN89	1	3	11:30	14:45	3	3.250	0	0
01JAN89 - 15JAN89	06JAN89	1	2	13:00	16:15	2	3.250	0	0
01JAN89 - 15JAN89	06JAN89	1	3	9:15	12:30	3	3.250	0	0
01JAN89 - 15JAN89	07JAN89	2	2	12:15	15:30	3	3.250	0	0
01JAN89 - 15JAN89	07JAN89	2	3	8:30	11:45	2	3.250	0	0
01JAN89 - 15JAN89	08JAN89	2	2	12:15	15:30	2	3.250	0	0
01JAN89 - 15JAN89	08JAN89	2	3	8:30	11:45	2	3.250	0	0
01JAN89 - 15JAN89	09JAN89	1	2	13:00	16:15	3	3.250	0	0
01JAN89 - 15JAN89	09JAN89	1	3	9:15	12:30	3	3.250	0	0
01JAN89 - 15JAN89	10JAN89	1	2	13:00	16:15	2	3.250	0	0
01JAN89 - 15JAN89	10JAN89	1	3	9:30	12:45	2	3.250	0	0
01JAN89 - 15JAN89	13JAN89	1	3	7:45	11:00	3	3.250	0	0
01JAN89 - 15JAN89	13JAN89	1	3	11:30	14:45	3	3.250	0	0
01JAN89 - 15JAN89	14JAN89	2	2	13:00	16:15	3	3.250	0	0
01JAN89 - 15JAN89	14JAN89	2	3	9:15	12:30	3	3.250	0	0
01JAN89 - 15JAN89	15JAN89	2	2	13:00	16:15	3	3.250	0	0
01JAN89 - 15JAN89	15JAN89	2	3	9:15	12:30	3	3.250	0	0
16JAN89 - 29JAN89	16JAN89	1	2	12:00	14:00	3	2.000	0	0
16JAN89 - 29JAN89	16JAN89	1	2	14:30	16:30	2	2.000	0	0
16JAN89 - 29JAN89	19JAN89	1	3	7:30	9:30	2	2.000	0	0
16JAN89 - 29JAN89	19JAN89	1	3	10:00	12:00	3	2.000	0	0
16JAN89 - 29JAN89	20JAN89	1	2	12:00	14:00	3	2.000	0	0
16JAN89 - 29JAN89	20JAN89	1	2	14:30	16:30	3	2.000	0	0
16JAN89 - 29JAN89	21JAN89	2	2	12:00	14:00	2	2.000	3	3
16JAN89 - 29JAN89	21JAN89	2	2	14:30	16:30	2	2.000	0	0
16JAN89 - 29JAN89	22JAN89	2	3	7:30	9:30	2	2.000	0	0
16JAN89 - 29JAN89	22JAN89	2	3	10:00	12:00	2	2.000	0	0
16JAN89 - 29JAN89	23JAN89	1	3	7:15	9:22	2	2.117	0	0
16JAN89 - 29JAN89	23JAN89	1	3	9:52	12:00	3	2.133	0	0
16JAN89 - 29JAN89	26JAN89	1	2	12:00	14:07	2	2.117	0	0
16JAN89 - 29JAN89	26JAN89	1	2	14:37	16:45	3	2.133	0	0
16JAN89 - 29JAN89	27JAN89	1	2	12:15	14:07	2	1.867	2	2
16JAN89 - 29JAN89	27JAN89	1	2	14:37	16:45	3	2.133	0	0
16JAN89 - 29JAN89	28JAN89	2	2	12:00	14:07	3	2.117	3	3
16JAN89 - 29JAN89	28JAN89	2	2	14:37	16:45	3	2.133	0	0
16JAN89 - 29JAN89	29JAN89	2	3	7:15	9:22	2	2.117	5	5
16JAN89 - 29JAN89	29JAN89	2	3	9:52	12:00	3	2.133	0	0

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Biweekly Period	Date of Sample	A[a]	B[b]	Start[c]	End[d]	C[e]	Samptime[f]	Count[g]	Interv[h]
30JAN89 - 12FEB89	30JAN89	1	2	12:30	14:15	2	1.750	0	0
30JAN89 - 12FEB89	30JAN89	1	2	14:45	17:00	3	2.250	0	0
30JAN89 - 12FEB89	31JAN89	1	3	7:00	9:15	2	2.250	0	0
30JAN89 - 12FEB89	31JAN89	1	3	9:45	12:00	3	2.250	0	0
30JAN89 - 12FEB89	03FEB89	1	2	12:00	14:15	3	2.250	0	0
30JAN89 - 12FEB89	03FEB89	1	2	14:45	17:00	3	2.250	0	0
30JAN89 - 12FEB89	04FEB89	2	2	12:00	14:15	3	2.250	0	0
30JAN89 - 12FEB89	04FEB89	2	2	14:45	17:00	3	2.250	0	0
30JAN89 - 12FEB89	05FEB89	2	3	7:00	9:15	2	2.250	0	0
30JAN89 - 12FEB89	05FEB89	2	3	9:45	12:00	2	2.250	0	0
30JAN89 - 12FEB89	06FEB89	1	3	6:45	9:07	2	2.367	0	0
30JAN89 - 12FEB89	06FEB89	1	3	9:37	12:00	3	2.383	0	0
30JAN89 - 12FEB89	07FEB89	1	2	12:00	14:22	3	2.367	0	0
30JAN89 - 12FEB89	07FEB89	1	2	14:52	17:52	2	3.000	0	0
30JAN89 - 12FEB89	10FEB89	1	2	12:00	14:22	3	2.367	0	0
30JAN89 - 12FEB89	10FEB89	1	2	14:52	17:15	3	2.383	0	0
30JAN89 - 12FEB89	11FEB89	2	2	12:00	14:22	3	2.367	0	0
30JAN89 - 12FEB89	11FEB89	2	2	14:52	17:15	2	2.383	0	0
30JAN89 - 12FEB89	12FEB89	2	3	9:37	12:00	3	2.383	0	0
13FEB89 - 26FEB89	13FEB89	1	2	12:15	14:37	3	2.367	0	0
13FEB89 - 26FEB89	13FEB89	1	2	15:07	17:30	3	2.383	0	0
13FEB89 - 26FEB89	16FEB89	1	3	7:00	9:22	3	2.367	0	0
13FEB89 - 26FEB89	16FEB89	1	3	9:52	12:15	2	2.383	0	0
13FEB89 - 26FEB89	17FEB89	1	2	12:15	14:37	3	2.367	0	0
13FEB89 - 26FEB89	17FEB89	1	2	15:07	17:30	3	2.383	0	0
13FEB89 - 26FEB89	18FEB89	2	2	12:15	14:37	3	2.367	3	3
13FEB89 - 26FEB89	18FEB89	2	2	15:07	17:30	3	2.383	0	0
13FEB89 - 26FEB89	19FEB89	2	3	7:00	9:22	3	2.367	0	0
13FEB89 - 26FEB89	19FEB89	2	3	9:52	12:15	3	2.383	1	1
13FEB89 - 26FEB89	20FEB89	1	3	6:15	8:52	3	2.617	0	0
13FEB89 - 26FEB89	20FEB89	1	3	9:22	12:00	3	2.633	0	0
13FEB89 - 26FEB89	23FEB89	1	2	12:00	14:37	2	2.617	0	0
13FEB89 - 26FEB89	23FEB89	1	2	15:07	17:45	2	2.633	1	1
13FEB89 - 26FEB89	24FEB89	1	2	12:00	14:37	3	2.617	0	0
13FEB89 - 26FEB89	24FEB89	1	2	15:07	17:45	2	2.633	0	0
13FEB89 - 26FEB89	25FEB89	2	2	12:00	14:37	3	2.617	0	0
13FEB89 - 26FEB89	25FEB89	2	2	15:07	17:45	3	2.633	1	1
13FEB89 - 26FEB89	26FEB89	2	3	6:15	8:52	3	2.617	0	0
13FEB89 - 26FEB89	26FEB89	2	3	9:22	12:00	3	2.633	0	0

(continued)

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Biweekly Period	Date of Sample	A[a]	B[b]	Start[c]	End[d]	C[e]	Samptime[f]	Count[g]	Interv[h]
27FEB89 - 12MAR89	27FEB89	1	2	12:00	14:45	3	2.750	0	0
27FEB89 - 12MAR89	27FEB89	1	2	15:15	18:00	3	2.750	0	0
27FEB89 - 12MAR89	02MAR89	1	3	6:00	8:45	2	2.750	0	0
27FEB89 - 12MAR89	02MAR89	1	3	9:15	12:00	3	2.750	0	0
27FEB89 - 12MAR89	03MAR89	1	2	12:00	14:45	2	2.750	0	0
27FEB89 - 12MAR89	03MAR89	1	2	15:15	18:00	2	2.750	0	0
27FEB89 - 12MAR89	04MAR89	2	2	12:00	14:45	3	2.750	0	0
27FEB89 - 12MAR89	04MAR89	2	2	15:15	18:00	3	2.750	0	0
27FEB89 - 12MAR89	05MAR89	2	3	6:00	8:45	3	2.750	0	0
27FEB89 - 12MAR89	05MAR89	2	3	9:15	12:00	2	2.750	1	1
27FEB89 - 12MAR89	06MAR89	1	3	6:15	9:00	3	2.750	0	0
27FEB89 - 12MAR89	06MAR89	1	3	9:30	12:15	3	2.750	0	0
27FEB89 - 12MAR89	09MAR89	1	2	12:15	15:00	2	2.750	0	0
27FEB89 - 12MAR89	09MAR89	1	2	15:30	18:15	2	2.750	0	0
27FEB89 - 12MAR89	10MAR89	1	2	12:15	15:00	3	2.750	0	0
27FEB89 - 12MAR89	10MAR89	1	2	15:30	18:15	3	2.750	0	0
27FEB89 - 12MAR89	11MAR89	2	2	12:15	15:00	3	2.750	0	0
27FEB89 - 12MAR89	11MAR89	2	2	15:30	18:15	2	2.750	0	0
27FEB89 - 12MAR89	12MAR89	2	3	6:15	9:00	3	2.750	0	0
27FEB89 - 12MAR89	12MAR89	2	3	9:30	12:15	2	2.750	0	0
13MAR89 - 26MAR89	13MAR89	1	2	12:15	15:07	2	2.867	0	0
13MAR89 - 26MAR89	13MAR89	1	2	15:37	18:30	3	2.883	0	0
13MAR89 - 26MAR89	14MAR89	1	3	6:00	8:52	3	2.867	0	0
13MAR89 - 26MAR89	14MAR89	1	3	9:22	12:15	2	2.883	0	0
13MAR89 - 26MAR89	15MAR89	1	2	12:15	15:07	3	2.867	1	1
13MAR89 - 26MAR89	15MAR89	1	2	15:37	18:30	3	2.883	0	0
13MAR89 - 26MAR89	18MAR89	2	2	12:15	15:07	3	2.867	0	0
13MAR89 - 26MAR89	18MAR89	2	2	15:37	18:30	3	2.883	0	0
13MAR89 - 26MAR89	19MAR89	2	3	6:00	8:52	3	2.867	0	0
13MAR89 - 26MAR89	19MAR89	2	3	9:22	12:15	3	2.883	0	0
13MAR89 - 26MAR89	20MAR89	1	3	6:00	8:52	3	2.867	0	0
13MAR89 - 26MAR89	20MAR89	1	3	9:22	12:15	2	2.883	0	0
13MAR89 - 26MAR89	23MAR89	1	2	12:15	15:07	3	2.867	4	4
13MAR89 - 26MAR89	23MAR89	1	2	15:37	18:30	2	2.883	0	0
13MAR89 - 26MAR89	24MAR89	1	2	12:15	15:07	3	2.867	4	4
13MAR89 - 26MAR89	24MAR89	1	2	15:37	18:30	2	2.883	3	3
13MAR89 - 26MAR89	25MAR89	2	2	12:15	15:07	2	2.867	4	4
13MAR89 - 26MAR89	25MAR89	2	2	15:37	18:30	3	2.883	1	1
13MAR89 - 26MAR89	26MAR89	2	3	6:00	8:52	3	2.867	0	0
13MAR89 - 26MAR89	26MAR89	2	3	9:22	12:15	2	2.883	0	0

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Biweekly Period	Date of Sample	A[a]	B[b]	Start[c]	End[d]	C[e]	Samptime[f]	Count[g]	Interv[h]
27MAR89 - 09APR89	27MAR89	1	2	12:30	15:22	3	2.867	0	0
27MAR89 - 09APR89	27MAR89	1	2	15:52	18:45	3	2.883	0	0
27MAR89 - 09APR89	30MAR89	1	3	6:15	9:07	2	2.867	3	3
27MAR89 - 09APR89	30MAR89	1	3	9:37	12:30	2	2.883	2	2
27MAR89 - 09APR89	31MAR89	1	2	12:30	15:22	3	2.867	0	0
27MAR89 - 09APR89	31MAR89	1	2	15:52	18:45	3	2.883	0	0
27MAR89 - 09APR89	01APR89	2	2	12:30	15:22	2	2.867	7	7
27MAR89 - 09APR89	01APR89	2	2	15:52	18:45	3	2.883	3	3
27MAR89 - 09APR89	02APR89	2	3	6:00	9:15	3	3.250	2	2
27MAR89 - 09APR89	02APR89	2	3	9:45	13:00	3	3.250	2	2
27MAR89 - 09APR89	03APR89	1	3	6:00	9:15	3	3.250	0	0
27MAR89 - 09APR89	03APR89	1	3	9:45	13:00	2	3.250	5	5
27MAR89 - 09APR89	06APR89	1	2	13:00	16:15	3	3.250	0	0
27MAR89 - 09APR89	06APR89	1	2	16:45	20:00	2	3.250	9	9
27MAR89 - 09APR89	07APR89	1	2	13:00	16:15	3	3.250	0	0
27MAR89 - 09APR89	07APR89	1	2	14:45	18:00	3	3.250	0	0
27MAR89 - 09APR89	08APR89	2	2	13:00	16:15	3	3.250	2	2
27MAR89 - 09APR89	08APR89	2	2	16:45	20:00	2	3.250	2	2
27MAR89 - 09APR89	09APR89	2	3	6:00	9:15	2	3.250	1	1
27MAR89 - 09APR89	09APR89	2	3	9:45	13:00	3	3.250	0	0
10APR89 - 23APR89	10APR89	1	2	13:15	16:30	3	3.250	0	0
10APR89 - 23APR89	10APR89	1	2	17:00	20:15	2	3.250	0	0
10APR89 - 23APR89	11APR89	1	3	6:15	9:30	3	3.250	0	0
10APR89 - 23APR89	11APR89	1	3	10:00	13:15	3	3.250	0	0
10APR89 - 23APR89	14APR89	1	2	13:15	16:30	3	3.250	1	1
10APR89 - 23APR89	14APR89	1	2	17:00	20:15	3	3.250	0	0
10APR89 - 23APR89	15APR89	2	2	13:15	16:30	2	3.250	3	1
10APR89 - 23APR89	15APR89	2	2	17:00	20:15	3	3.250	1	1
10APR89 - 23APR89	16APR89	2	3	6:15	9:30	3	3.250	1	1
10APR89 - 23APR89	16APR89	2	3	10:00	13:15	3	3.250	2	2
10APR89 - 23APR89	17APR89	1	3	6:00	9:15	3	3.250	0	0
10APR89 - 23APR89	17APR89	1	3	9:45	13:00	2	3.250	2	2
10APR89 - 23APR89	18APR89	1	2	13:15	16:30	3	3.250	0	0
10APR89 - 23APR89	18APR89	1	2	17:00	20:15	3	3.250	0	0
10APR89 - 23APR89	21APR89	1	2	13:15	16:30	3	3.250	0	0
10APR89 - 23APR89	21APR89	1	2	17:00	20:15	2	3.250	8	8
10APR89 - 23APR89	22APR89	2	2	13:15	16:30	3	3.250	2	2
10APR89 - 23APR89	22APR89	2	2	17:00	20:15	3	3.250	0	0
10APR89 - 23APR89	23APR89	2	3	6:15	9:30	3	3.250	0	0
10APR89 - 23APR89	23APR89	2	3	10:00	13:15	2	3.250	6	6

(continued)

Biweekly Period	Date of Sample	A[a]	B[b]	Start[c]	End[d]	C[e]	Samptime[f]	Count[g]	Interv[h]
24APR89 - 07MAY89	26APR89	1	2	14:15	17:30	2	3.250	2	2
24APR89 - 07MAY89	26APR89	1	2	18:00	21:15	3	3.250	0	0
24APR89 - 07MAY89	27APR89	1	3	6:15	9:30	3	3.250	1	1
24APR89 - 07MAY89	27APR89	1	3	10:00	13:15	3	3.250	0	0
24APR89 - 07MAY89	28APR89	1	2	13:30	16:45	2	3.250	5	5
24APR89 - 07MAY89	28APR89	1	2	17:15	20:30	3	3.250	0	0
24APR89 - 07MAY89	29APR89	2	2	13:45	17:00	2	3.250	8	6
24APR89 - 07MAY89	29APR89	2	2	17:30	20:45	2	3.250	4	1
24APR89 - 07MAY89	30APR89	2	3	6:30	9:45	3	3.250	0	0
24APR89 - 07MAY89	30APR89	2	3	10:15	13:30	3	3.250	1	1
24APR89 - 07MAY89	01MAY89	1	2	17:30	20:45	2	3.250	12	8
24APR89 - 07MAY89	01MAY89	1	3	6:45	10:00	2	3.250	1	1
24APR89 - 07MAY89	02MAY89	1	2	13:45	17:00	3	3.250	0	0
24APR89 - 07MAY89	02MAY89	1	2	17:30	20:45	2	3.250	12	11
24APR89 - 07MAY89	03MAY89	1	2	14:15	17:30	3	3.250	0	0
24APR89 - 07MAY89	03MAY89	1	2	18:00	22:15	2	4.250	15	15
24APR89 - 07MAY89	06MAY89	2	2	14:15	17:30	3	3.250	0	0
24APR89 - 07MAY89	06MAY89	2	2	18:00	21:15	2	3.250	10	10
24APR89 - 07MAY89	07MAY89	2	3	6:45	10:00	3	3.250	0	0
24APR89 - 07MAY89	07MAY89	2	3	10:30	13:45	2	3.250	10	10
08MAY89 - 21MAY89	10MAY89	1	2	14:30	17:45	2	3.250	11	8
08MAY89 - 21MAY89	10MAY89	1	2	18:15	21:30	3	3.250	4	4
08MAY89 - 21MAY89	11MAY89	1	3	6:45	10:00	2	3.250	5	5
08MAY89 - 21MAY89	11MAY89	1	3	10:30	13:45	3	3.250	0	0
08MAY89 - 21MAY89	12MAY89	1	2	14:30	17:45	2	3.250	9	8
08MAY89 - 21MAY89	12MAY89	1	2	18:15	21:30	2	3.250	7	6
08MAY89 - 21MAY89	13MAY89	2	2	14:30	17:45	3	3.250	0	0
08MAY89 - 21MAY89	13MAY89	2	2	18:15	21:30	2	3.250	5	5
08MAY89 - 21MAY89	14MAY89	2	3	6:00	9:15	2	3.250	4	4
08MAY89 - 21MAY89	14MAY89	2	3	9:45	13:00	3	3.250	0	0
08MAY89 - 21MAY89	17MAY89	1	3	7:00	10:15	3	3.250	0	0
08MAY89 - 21MAY89	17MAY89	1	3	10:45	14:00	2	3.250	11	11
08MAY89 - 21MAY89	18MAY89	1	2	14:00	17:15	3	3.250	0	0
08MAY89 - 21MAY89	18MAY89	1	2	17:45	21:00	2	3.250	3	2
08MAY89 - 21MAY89	19MAY89	1	2	14:15	17:15	3	3.000	0	0
08MAY89 - 21MAY89	19MAY89	1	2	17:45	21:00	3	3.250	2	2
08MAY89 - 21MAY89	20MAY89	2	2	14:45	18:00	3	3.250	0	0
08MAY89 - 21MAY89	20MAY89	2	2	18:30	21:45	3	3.250	0	0
08MAY89 - 21MAY89	21MAY89	2	3	6:15	9:30	3	3.250	0	0
08MAY89 - 21MAY89	21MAY89	2	3	10:00	13:15	3	3.250	0	0

[a] A = type of day (1 = weekday, 2 = weekend)
[b] B = period of the day (1 = early day, 2 = late day, 3 = all day)
[c] start of the sampling period
[d] end of the sampling period
[e] C = access location (1 = Highway to Ward Lake, 2 = Lake to swinging bridge, 3 = Swinging bridge to Connell Dam)
[f] duration of sample in hours
[g] number of anglers counted
[h] number of anglers interviewed